Impact Analysis of the Built Environment on Quality of Life

-- A Case Study in the City of Atlanta

Jing Kong

Option Paper

Instructed by Professor Timothy Welch

School of City and Regional Planning

Georgia Institute of Technology

May 2017

Table of Contents

Abstract

This paper aims to assess the relationship between quality of life (QOL) and the built environment in the City of Atlanta. Due to the complexity of the concept of quality of life, this study focuses on objective measurements which involve tangible objects such as employment, economic status, education level and one's social and physical environment. Specifically, these indicators are the average travel time, employment rate, nonpoverty rate, housing affordability, education attainment, and shortest distance to public facilities. The built environment is assessed from measures of population density, transit accessibility, and street connectivity, and the share of four types land uses (residential, commercial, industrial, and greenspace). The relationship between QOL and built environment is examined through regression analysis.

The result indicates that there are some relationships between the built environment and quality of life. Among the four-built environment variable categories, transit accessibility, population density, and mixed uses of residential, commercial and industrial spaces have a positive relationship with QOL, while the ratio of greenspace shows negative impacts on QOL index and street density does not have relationship with QOL index.

Introduction

Quality of life is a complex and multifaceted assessment of the overall well-being of people. The goal of city planning is to improve the city and help people achieve a better standard of living. A significant amount of research on the quality of life has analyzed QOL from various perspectives, including economics, political science, sociology, psychology, health studies, housing, marketing, cities level analysis, urban analysis (Mohit, 2013). Due to the extensive range of QOL indicators, it's hard to include all factors into a QOL index. Thus, the QOL index in this study focuses more on general social demographics and community well-being.

Built environment refers to where people live, work and spend time. So, people are closely connected with the built environment on a daily business. Studies of built environment are more concerned about one or some aspects of quality of life, such as physical activities, mobility, or public health, etc. (Moudon et at., 2005, Berke et al.,). The built environment and the process of development can also encourage the creation or support of existing neighborhood and support networks, help develop a sense of identity, and provide opportunities for training, education and employment (Sassi 2006). Therefore, impacts of the built environment on quality of life can point out strategies or directions for city improvement. This paper connects the two concepts and intends to figure out their potential relationships and discuss potential reasons based on local context.

Literature Review

Built Environment and Travel Behavior

Built environment has been researched from its relation to travel behavior and public health. Measurements of relation between travel behavior and built environment include density, diversity, design (Cervero, 1997), followed later by destination accessibility and distance to transit (Ewing & Cervero, 2001). Ewing, in his meta data analysis, concludes that travel variables are generally inelastic with respect to change in measure of the built environment. He finds that vehicle miles traveled (VMT) is most strongly related to measures of accessibility to destinations and secondarily to street network design variables. Walking is most strongly related to measures of land use diversity, intersection density, and the number of destinations within walking distance. And population and job densities are only weakly associated with travel behavior once other variables are controlled (Ewing & Cervero, 2010).

In relation to health, built environment is assessed with transportation related physical activities, especially biking and walking (Frank, 2000;). Transport related physical activities refer to activities that are undertaken to accomplish another purpose, such as transporting the person to another place using active modes (e.g., walking or cycling) (Frank & Engelke, 2001). Koohsari et al. (2013) points two dimension of built environment, geographic scale and threshold, as important research features in considering the relation between built environment and physical activity. One asks questions of what are the optimal scale for certain activity; while the other is more about the actual measure or effort needed for activity (Koohsari et al., 2013). The two dimensions vary with respect to different demographics and types of physical activity. Van Dyck et al. (2012) investigate the direction and shape of relationships between perceived neighborhood attributes and transport-related cycling and walking in the USA, Australia and Belgium. Their research identifies several sites- and gender-specific interactions for transport-related walking. Moreover, the built environment correlations of transport-related walking are different than the factors related to cycling, supporting the need for a behavior-specific focus (Van Dyck et al., 2012).

Mixed land use, residential density, street connectivity, and commute distance have been identified as potential variables affecting transport-related physical activity (TPA) behaviors (Badland et al., 2005). Based on objective GIS analysis of commuting to place of work or study, Badland concludes that commute distance has an influence on TPA behaviors, and street network connectivity affects TPA engagement (Badland et al, 2008). Non-automobile transportation improvements and more comprehensive policies to guide development are positively associated with physical activity (Aytur at el., 2008). Van Dyck's study (2012) identifies the relationship between biking/ walking and influencing factors. Cycling shows a linear positive association with a composite index combing proximity of destinations, availability and quality of walking and cycling facilities, aesthetic and parking difficulties. And transport-related walking shows a curvilinear association with 'walkability' index which includes residential density, land use mix-access, proximity to destinations and aesthetics (Van Dyck et al., 2012). Kelly Schwartz et al., (2004) suggests that influence of sprawl on health is both positive and negative, with greater street connectivity promoting better health but greater density related to poorer overall health ratings (Kelly Schwartz et al, 2004).

Spatial Development Theories

Built environment is a component of the spatial layout of a city. There are different theories behind the spatial development of a city. Spatial mismatch hypothesis was first put forward by Kain (1968) when he found the location of jobs for blacks was a poor predictor of their residences (Kain, 1968). The residential segregation in turn exacerbates skill segregation. Metropolitan areas became more radically integrated, made virtually no progress with respect to skill-based integration and exhibited greater city-suburb income disparities (Li, 2013). Fan (2012) classifies spatial mismatch mitigation strategies into land use, economic development, housing, and transportation groups and evaluates the success that failures of each strategy group. The evaluations show most strategies is inconsistent and the effectiveness of those strategies remains unclear, except for strategy of promoting car ownership. The conclusion is, surprisingly, that car ownership programs consistently shows positive effects, therefore recommending expansion of car ownership (Fan, 2012).

Contrary to spatial mismatch, compact development is an opposite development strategy. A comparison study shows while prototypes of spatial theory, such as compaction, sprawl, edge expansion, and new towns, are indeed found to differ in their sustainability, no one form is clearly superior. The author concludes compact development should not automatically be associated with the preferred spatial growth strategy due to potential negative consequences such as less housing choice, crowding and congestion (Echenique et al., 2012)

From the perspective of spatial form, comparing spatial effects on travel distance, Rau suggests that the ‘city of short distances’ is just as much a ‘city of long-distance journeys’. Therefore, the hope that travel can be reduced by boosting urbanization—concentrating development on large cities, density, and land-use mix—has to be curtailed. Another concern is the impact of self-selection on urban development pattern (Rau, 2012). The actual impact is unclear. As some studies find residential self-selection attenuates the effects of the built environment on travel behavior (Cao, 2009). However, Chatmat's test on self-selection finds that self-selection is more likely to enhance than diminish built environment influences (Chatman, 2009).

Quality of Life

Quality of life is a multifaceted concept which has been used by a variety of disciplines for benchmarking and development policy purposes (Mohit, 2013). QOL has to do with the 'goodness' of life, and being able to live successfully and happily within our environments. From professional perspective, the essential meaning of QOL in general should be universally understood, but when the concept is applied to individual people or groups of people, different aspects of QOL may dominate over others (Brown & Brown, 2005).

Different research purposes may lead to different composition of indicators of QOL. It is perhaps not surprising that there is neither an agreement upon definition nor standard form of measurement (Cummins, 1997). WHO in 1991 developed an international cross cultural comparable quality of life assessment instrument called WHOQOL-BREF. The WHOQOL-BREF group defines QOL as "an individual's perception of his/her position in the context of culture and value systems in which they live in and in relation to their goals, expectations, standards and concerns. It is a broad-ranging concept incorporating, in a complex way, the person's physical health, psychological state, level of independence, social relationships, personal beliefs and relationships to salient features of the environment” (WHOQOL Group, 1998).

Quality of life applications enhance well-being within cultural contexts (Brown et. al. 2005). In terms of compositions of QOL indicators, according to the definition of quality of life, the selected variables should capture the social and economic well-beings of people. The approaches to construct quality of life model vary depending on research purposes. Previous studies have pointed out different frameworks for QOL index. Quality of life domains refer to the set of factors composing personal well-being and should be thought of as the range over which the QOL construct extends. The most frequently referenced QOL domains (in descending frequency) are: interpersonal relations, social inclusion, personal development, physical well-being, self-determination, material well-being, emotional well-being, rights, environment (home/residence/living situation), family, recreation and leisure, and safety security (Verdugo et al. 2005). Nakanishi et al (2006) developed an integrated planning support tool that can reflect the individual’s value on the evaluation of QOL. In her research, individual’s quality of life is defined by the set of satisfaction level and values assigned to each of the five domains of QOL being – community safety and security, prosperity and diversity, cultural and education, community well-being, and quality environment and sustainability. This research uses quantitative method to measure people’s perceptions from surveys. Doi’s study (2008) includes similar QOL elements, safety and security, economic opportunity, service and cultural opportunity, spatial amenity, and environmental benignity. Mohit (2013) proposed three theoretical perspectives of QOL-- happiness and life satisfaction approach, the needs satisfaction approach, and life satisfaction based on need satisfaction. Puskorius (2015) suggests using

Maslow's hierarchical list of motives as a framework of QOL and assign weights based on the hierarchy. Although there are ample researches about quality of life, there isn't an agreement among sociologists and other social scientists on methods for aggregating social indicators to create a QOL index that is useful for public discourse on social well-being and policy issues relevant thereto (Hagerty et al, 2006).

In planning-related studies on quality of life, some researches analyze the relationships between quality of life and one aspect of planning. Doi et al. (2008) developed a QOL-based accessibility measure and a QOL performance measure to address appropriate policies of land use-transportation coordination and integration by disentangling the mismatch between real urban structures and people's demands for quality of life. An empirical analysis of multidimensional, spatial-temporal quality of life trends followed by neighborhoods in Charlotte, NC, indicates that the neighborhoods of the highest QOL index were most stable with lower homeownership, and closer distances to the city center (Delmelle et al. 2013). Thompson et al (2013) examined the influence of greenspace on individual's perception of woodlands and quality of life using subjective data. This study finds that quality of neighborhood environment has positive impacts on quality of life.

Methodology and Data Analysis

This paper uses regression analysis to find the relationship between quality of life and the built environment in the City of Atlanta. The research is conducted at census tract level, as shown in figure 1, including a total of 151 census tracts with usable data, and two excluded tracts without valid data. GIS-based analyses are used to manage data based on spatial locations and street network. The regression analysis is conducted in SPSS with linear regression function to find the relationship between QOL and the built environment. Table 1 shows all data used for this research and their resources. Selected variables should meet these criteria: 1) Availability: the variables should be available at census tract level; 2) Measurable: all variables should be quantitatively measurable; 3) Independent. The correlation among one group of indicators are small.

Figure 1. Research Area—City of Atlanta at Census Tract Level

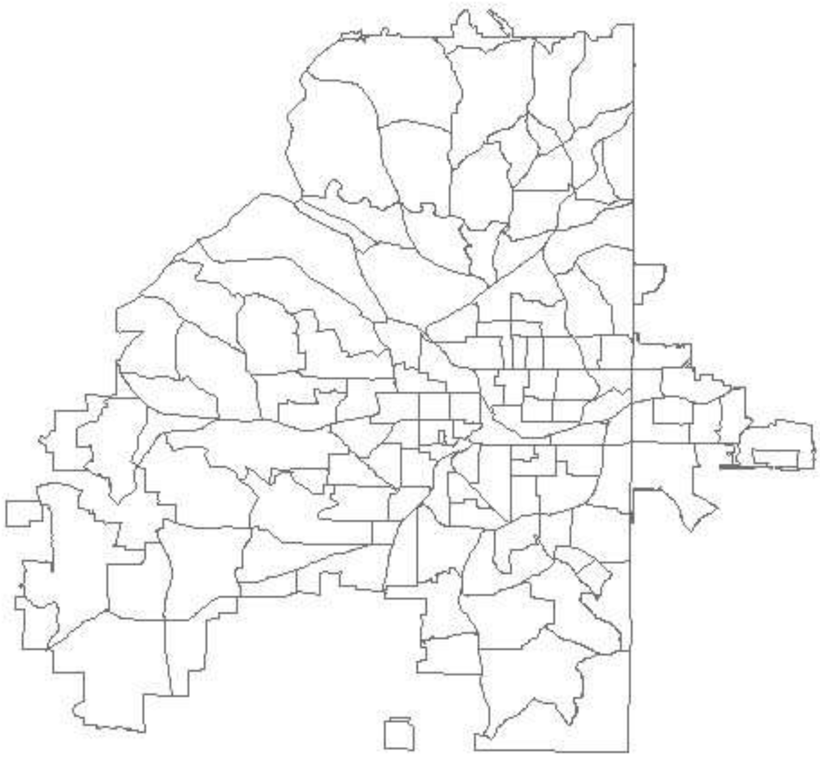

Table 1. Data Sources

Data	Sources
Land use shapefile; Road and street shapefile; Transit stations shapefile; City of Atlanta boundary shapefile	Atlanta Regional Commission Open Data
Census tract and block shapefile	U.S Census Bureau TIGER/Line Shapefiles
Social demographic data: nonpoverty rate employment rate median house value educational attainment average travel time population density.	2011-2015 five-year American Community Survey
Monthly interest rate of Georgia State from 2011 to 2015	HSH.com (a publisher of mortgage and consumer loan information)

Quality of Life Index

This study focuses on objective measures of QOL due to the small geometry scale of research (151 tracts) and the difficulty of conducting community survey at such small scale. Two questions about measuring QOL stand out. One is which indicators are suitable for QOL measurements. The other is how to determine weight for each variable to compute an index? Since there is no agreement on indicators and methods for aggregating indicators to create a QOL index, this paper builds a QOL index with available data. These indicators are classified into three domains of QOL, which are economic status, community well-being, and education. For each domain, detailed indicators are selected considering data availability and their relevance to social well-beings. As shown in table 2, economic status is represented by nonpoverty rate, employment rate and housing affordability; community well-being is represented by average travel time to work, and distance to public facilities; and education is represented by education attainment of population over 25 years old.

Weight for each variable indicates individual's preference of one aspect over another. Essentially, the weighting process is largely influenced by individual differences. Weights are important in that it relates to the agreement on the overall QOL index. The larger the proportion of people agree on assigned weights, the higher the chance that the QOL index will be well accepted by citizens. Some studies conduct public surveys to collect personal opinions on weights. However, for studies that do not incorporate survey data, weighting is difficult. Although this study does not include community survey data, it's still expected to achieve maximum acceptance of QOL index through reasonable weighting. Hagerty and Land (2006) defines a mini-max estimator as estimator that minimizes maximum possible disagreement. According to their research, the equal weighting of indicators is the minimax estimator that minimizes disagreement even among diametrically opposed individuals when data of individuals' preferences from survey do not exist (Hagerty and Land, 2006). Therefore, this study will use equal weighting for indicators of QOL index. In addition, selected indicators are positively related to QOL. For example, people prefer higher nonpoverty rate and employment rate.

The integral of quality of life index can be calculated using the following formula:

$$QOL=\sum_{i}^{5} a_i b_i$$

Where

b_i-value of summarized indicator

a_i- weight coefficient of indicator b_i

As equal weighing is used in this study, the QOL index calculation can be simplified as the sum of the value of each summarized indicator. The following will exhibit how each indicator is summarized.

Table 2. Quality of Life Index Indicators

Domain	Quality of Life Indicators
Economic status	Nonpoverty rate; employment rate; housing affordability.
Community well-being	Ratio of population within 30 and 60 minutes' travel time to work, Distance to public facilities
Education	Education attainment of population over 25 years-old

Housing Affordability Index

According to the National Association of Realtors (NAR), the housing affordability index measures whether or not typically family earns enough income to qualify for a mortgage loan on a typical home. Therefore, Housing Affordability Index is calculated as the ratio between median family income and qualifying income which refers to income that is qualified for a mortgage loan on a typical home. A value of one means that a family with the median income has exactly enough income to qualify for a mortgage on a median-priced home. An index above one signifies that family earning the median income has more than enough income to qualify for a mortgage loan on a median-priced home, assuming a 20 percent down payment (NAR). Interest rate used in this study are the average of monthly interest rate of the state of Georgia from 2011 to 2015. Considering that HAI are small and none of them is larger than 1, replacing missing numbers with zero will not skew quality of life index.

The formula for calculation are as follows:

Monthly payment= MEDPRICE*0.8*(IR/12)/(1-(1/(1+IR/12) ^360))

Qualifying Income (QINC)= PMT*4*12

$$\text{Housing Affordability Index} = \text{MEDINC}/\ \text{QINC}$$

Where,

MEDPRICE= median house value

IR= yearly interest rate

MEDINC= median family income

QINC= qualifying income

Average Travel Time

Average travel time measures commute time of work trips. Commute time is considered as non-productive time, especially for drivers. Short commute time also means more time spending on other things. In this study, commute time within thirty and sixty minutes are considered as helpful to achieve better quality of life. This indicator represents the proportion of people that can commute to work within thirty and sixty minutes. It has a positive relationship to QOL index, that is, the larger the number of population with short commute time, the higher the QOL index.

Education Attainment

The American Community Survey provides data of the number of population over 25 years under seven-category education levels, from less than high school to over doctorate degree. This study assumes that individuals with college or higher than college degree are more likely to achieve a higher standard of living. Therefore, this indicator measures the ratio of population with college or higher than college degree.

Distance to Closest Public Facilities

Distances to public facilities have an impact on the convenience of life to an extent. In this study, five public facilities are selected to calculate distance, which are activity centers, fire stations, hospitals, greenspace, and libraries. Point shapefiles of these facilities are from Atlanta Regional Commission Open Data. This study uses OD-Matrix Analysis function under the Network Analysis in ArcGIS to calculate the distance between the centroids of each census tract to the five-category facilities. Unlike Euclidean distance which calculates straight-line distance between two points, street network analysis considers accessible and connected streets. So, distances based on street network are more accurate. The shortest distances from every centroid to the closest five-category facilities are extracted for analysis.

For activity centers, greenspace and libraries, the raw distances are converted to ratios over one-mile threshold, and over 5-mile threshold for fire stations and hospitals. One-mile is about twenty-minutes' walk which is considered as acceptable walking distance. The ratios show the percentage that the shortest distances to activity centers, greenspace and libraries are larger or smaller than the acceptable walking distance. For fire stations and hospitals, automobile is more commonly used than walking. Therefore, a five-mile threshold which is about 5 minutes' drive, is employed to compare distance to fire stations and hospitals. To make these indicators positively relate to QOL index, the ratios are multiplied by -1. Thus, the larger the ratio, the smaller the distance to each facility.

As all the indicators are summarized and presented as ratio, the quality of life index can be calculated as the total of all indicators: nonpoverty rate, employment rate, housing affordability, ration of population within thirty and sixty minutes' commute time, distance to public facilities, population with college or higher than college degree.

Built Environment Indicators

Research has proposed measurements of built environment. The most commonly used measures are referred to as the 3Ds, density, diversity, and design. This study also employs these measures of the built environment.

Table 3. Built environment indicators

DOMAIN	INDICATORS
DIVERSITY	Share of residential, commercial, industrial, and greenspace land uses
DENSITY	Population density
	Ratio of population within 0.25 buffer around transit stations
DESIGN	Street network: Average block length per square mile

Land Use Diversity

Land use diversity measures the share of land area by different land-use types in each tract. Mixed land-use development refers to the coexistence of different land use types, such as residential, commercial, office space, greenspace, etc. Previous researches suggest that a greater mixture of complementary land use types is related to people's propensity to walk and thus to be physically active, transit use, and property values (American Planning Association, 1998) (Yan Song* and Daniel A. Rodríguez).

This study analyzes the mix of four types of land uses, which are residential, commercial, industrial, and greenspace uses since the four types are closely related to living and working. Although these data are at census tract level, the actual distribution of land uses cross the boundaries of tracts. Two tools in ArcGIS are used to extract land area of the four land-use types within a tract. The first tool is Make Feature Layer tool which can split geometry based on the ratio of land use area under the Use Ratio Policy. Thus, each land use type is split based on the ratio of land-use area. Then Identify tool is used to compute a geometric intersection of land-use types and tract feature. Thus, a new feature class with split land-use types within each census tract is created and ready to calculate land-use area ratio. Then the total and ratio of each of the four land-use types within each tract are calculated for analysis.

Population Density and Transit Accessibility

Population density data are from five-year American Community Survey at census tract level. Transit accessibility assesses the number of population that are within the service area of a transit station. A quarter mile is the commonly accepted distance for a person willing to walk to use transit (Demetsky and Lin 1982). Therefore, a 0.25-mile buffer is created around each transit station and all buffers are dissolved to eliminate overlapping area. Make feature Layer and Identify tools in ArcGIS are utilized to calculate the service area of transit stations within each tract. Assuming even distribution of population, transit station served population can be calculated by multiplying population density and the service area of transit stations.

Street Density

Street density measures block length per square feet in each tract. Street network is associated with the distribution of blocks. Small blocks in a land lot mean more streets are needed to connect each block. More connected blocks and streets can help reduce travel distance and encourage active travel mode such as walking and biking. So, street density is an important feature in measuring deign of built environment.

Result Analysis

To find the relationship between quality of life and the built environment, a regression analysis is conducted in SPSS. The linear regression result shows that most of the variables of the built environment do have some impacts on quality of life. Table 4 lists the input data for the regression model.

Table 4. Regression Model Input Variables

Dependent Variables	Independent Variables
QOL index	Industrial area ratio, commercial area ratio, greenspace area ratio, residential area ratio, block length per square foot, transit served population ratio, population density

Table 5. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.714[a]	.510	.486	1.315358336052950

a. Predictors: (Constant), served pop ratio, greenspace ratio, residential ratio, population density, block length per square foot, industrial ratio, commercial ratio

Table 5 is the summary of this linear regression model. The adjusted R square explains the percentage of variations that are explained by the independent variables. Although the number is not as high as 90 percent to make this model very substantial, 48 percent of adjusted R square is already convincing since this model incorporates only built environment variables while quality of life has a larger scope. Therefore, this model is reliable.

Table 6. Coefficients Result

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.826	.665		2.745	.007
	street density	3.590	8.439	.031	.425	.671
	population density	.000	.000	.256	3.408	.001
	commercial ratio	2.268	1.089	.197	2.083	.039
	residential ratio	2.574	.697	.353	3.691	.000
	industrial ratio	1.695	.849	.178	1.996	.048
	greenspace ratio	-3.158	1.262	-.183	-2.503	.013
	transit served population ratio	1.818	.395	.357	4.599	.000
a. Dependent Variable: QOL index						

As shown in table 6, the p-values (Sig.) of all variables except street density are smaller than 0.05, meaning that they are statistically significant at 95 percent of confidence. It signifies that the variables of significant p-values are good predictors of the QOL index. Street density variable does not have impact on QOL index due to its large P value of 0.671. One possible reason for the result is that street density has larger influences on walking or biking because a shorter travel distance mean more to pedestrians and riders than to vehicle drivers. Considering the large proportion of vehicle trips in the City of Atlanta, street density may have little impact on people, and therefore little impact on QOL index. Another conjecture is that the impact of street density can be two-sided. It can be positive when it helps to distract traffic, reduce travel distance, or encourage active travel modes. However, it may decrease quality of life when streets are so dense that traffic congestions or fast-moving vehicles are brought into neighborhoods. It may also bring environmental or safety issues to neighborhoods. These are only some suspects, so more data or analysis in other places are needed to test the irrelevance of street density.

For variables with significant relationship with QOL index, their relevance can be interpreted from the standardized coefficients shown in table 6. The ratio of population within 0.25-mile around a transit station has the highest impact on QOL index, with a standardized coefficient of 0.357 which means that an increase of one standard deviation in transit served population ratio results in an increase of 0.357 in QOL index, controlling other variables as constant. The large impact of the ratio of transit served population shows the importance of transit services in improving quality of life. It is consistent with current transit oriented development strategies.

The ratio of residential area has the second large impact on QOL index. QOL index will increase 0.353 for every increase of one standard deviation in the share of residential use, controlling other variables. Similarly, every increase of one standard deviation in population density will increase the QOL index by 0.256, controlling other variables. The comparatively large impacts of residential ratio and population density are probably due to the clusters of living-related services around residential area, such as grocery stores, restaurants, as well as public services. These businesses improve the convenience of living, and may potentially attract more other businesses. The ratios of commercial and industrial area have similar impacts on QOL index, with standardized coefficient of 0.197 and 0.178 respectively. For every one unit increase of a standard deviation in ratios of commercial and industrial area, QOL index will increase 0.179 and 0.178 respectively, controlling other variables.

Together, the impacts of residential, commercial and industrial share on QOL index proves that mixed land-uses development plays a significant role in improving quality of life. The existence of commercial and industrial land-uses around residential lots can help achieve job-housing balance, reduce excess commuting and travel time. Although the mix of residential and industrial land uses does not necessary mean that people living in that tract work at the same tract, it enlarges the possibility. In addition, mixed-use development can facilitate community activities and communications among residents and therefore help build sense of community.

It's surprising that greenspace has a negative impact on QOL index, indicating that every increase of one standard deviation of greenspace ratio results in a decrease of 0.183 in QOL index. However, previous researches have shown that greenspace has impacts on various aspects of quality of life, such as improving environmental quality, promoting a sense of community, improving mental, physical and community health, etc. (Ferguson, 2002). Due to data availability limitation, the result from this model needs to be further researched. One possible reason for this result is that the quality of life index does not include health- or environment-related indicators. The regression model focuses more on economic status and transportation related activities. Thus, greenspace takes up the land lots that could be used to for commercial or office spaces which produce economic values and help achieve job-housing balance in the surrounding area. Therefore, further researches and more data are needed to examine the result.

Conclusion and Implications

The quality of life has a big scope including almost everything in life. And the perception of quality of life differs among people due to differences in individuals' preferences. Therefore, a comprehensive analysis on all factors of quality of life is unrealistic. This study focuses on the impact of built environment on quality of life.

The regression result indicates that the built environment has influences on quality of life from several aspects. Population density, ratio of transit stations- served population, share of commercial, residential and industrial land-uses all exhibit positive impacts on QOL index. Among them, the ratio of transit stations-served population has the highest impact. It signifies the importance of transit services in improving quality of life. Share of residential land use has the second highest impact on QOL index, followed by population density.

High population density can attract businesses and services supporting daily life, and thus providing convenient living environment in the region. Share of residential and industrial ratio have similar impacts on QOL index. Together with residential land use, this result proves that mixed-use development is helpful to improve quality of life. High coverage of transit service, mixed-use development and high population density depict a compact development with good connectivity and accessibility to retails, restaurants, work place, and transit services, etc. Therefore, the result illustrates potential development strategies in future development:

- Advocate compact development rather than sprawl.
- Provide convenient living environment through mixed-use development
- Increase accessibility and coverage of public transportation services.

Contrary to those factors analyzed above, two factors have controversial results. The regression result shows that street density do not have an impact on quality and that share of greenspace has negative impact on quality of life. A potential explanation is that street density has more impacts on walking and biking rather than on driving, while the number of walking and biking trips are small in City of Atlanta. Another one is that dense street network may bring side effects into neighborhoods, such as air pollution, congestion, noise, etc. In terms of the negative impact of greenspace, it is probably due to the limitation of the QOL index which does not include health and environmental quality related data. Therefore, further researches and more data are needed to examine the results.

All in all, the regression model justifies and figures out the several aspects of the built environment that have impacts on quality of life. These aspects with significant influences on quality of life, in turn, point out strategies to improve the built environment and provide better quality of life for people; although more data are needed for further research on the two controversial variables.

Limitations

Due to the lack of subjective data excludes weighting process for indicators. Although equal weighting is most commonly accepted weighting system as explained before, incorporating subjective surveys can make the index more representative. In addition, QOL indicators are not comprehensive enough. Safety, health and environment quality related data are not available for this study. Therefore, further research and more data are needed to testify the impacts of street density and greenspace on quality of life.

References

Badland, H. M., Schofield, G. M., & Garrett, N. (2008). Travel behavior and objectively measured urban design variables: Associations for adults traveling to work. Health & Place, 14(1), 85–95.

Badland, H., & Schofield, G. (2005). Transport, urban design, and physical activity: an evidence-based update. Transportation Research Part D: Transport and Environment, 10(3), 177–196.

Badland, H. M., Schofield, G. M., & Garrett, N. (2008). Travel behavior and objectively measured urban design variables: Associations for adults traveling to work. Health & Place, 14(1), 85–95.

Berke, E. M., Koepsell, T. D., Moudon, A. V., Hoskins, R. E., & Larson, E. B. (2007). Association of the Built Environment with Physical Activity and Obesity in Older Persons. American Journal of Public Health, 97(3), 486–492. http://doi.org/10.2105/AJPH.2006.085837Brown, R. I., and I. Brown. 2005. "The Application of Quality of Life." Journal of Intellectual Disability Research 49 (10): 718–727.

Cao, X. (Jason). (2009). Disentangling the influence of neighborhood type and self-selection on driving behavior: an application of sample selection model. Transportation, 36(2), 207–222.

Cervero, R., Kockelman, K. (1997). Travel Demand and the 3Ds: Density, Diversity, and Design. Transportation Research Part D: Transport and Environment, (2), 199-219.

Chatman, D. G. (2009). Residential Choice, the Built Environment, and Nonwork Travel: Evidence Using New Data and Methods. Environment and Planning A, 41(5), 1072–1089. Environment and Planning A, 41(5), 1072–1089

Cummins, Robert A., and Deakin University. 1997. Comprehensive Quality of Life Scale: School Version (grades 7-12): Manual. 5th ed. (ComQol-S5). Burwood, Vic.: Deakin University, School of Psychology.

Delmelle, Elizabeth, Jean-Claude Thill, Owen Furuseth, and Thomas Ludden. 2013. "Trajectories of Multidimensional Neighborhood Quality of Life Change." Urban Studies 50 (5): 923–41. doi:10.1177/0042098012458003.

Demetsky, M. J., and B. Lin. 1982. Bus stop location and design. Transportation Engineering Journal of ASCE 108:313-327.

Doi, Kenji, Masanobu Kii, and Hitomi Nakanishi. 2008. "An Integrated Evaluation Method of Accessibility, Quality of Life, and Social Interaction." Environment and Planning B: Planning and Design 35 (6): 1098–1116. doi:10.1068/b3315t.

Echenique, M. H., Hargreaves, A. J., Mitchell, G., & Namdeo, A. (2012). Growing Cities Sustainably: Does Urban Form Matter? Journal of the American Planning Association, 78(2), 121–137.

Ewing, R., & Cervero, R. (2001). Travel and the built environment. Transportation Research Record, 1780, 87–114.

Ewing, R., & Cervero, R. (2010). Travel and the Built Environment: A Meta-Analysis. Journal of the American Planning Association, 76(3), 265–294.

Fan, Y. (2012). The Planners' War against Spatial Mismatch: Lessons Learned and Ways Forward. Journal of Planning Literature, 27(2), 153–169.

Frank, L. D., & Engelke, P. O. (2001). The built environment and human activity patterns: exploring the impacts of urban form on public health. Journal of Planning Literature, 16(2), 202–218.

Frank, L. D. (2000). Land use and transportation interaction implications on public health and quality of life. Journal of Planning Education and Research, 20(1), 6–22.

Hagerty, Michael R., and Kenneth C. Land. 2007. "Constructing Summary Indices of Quality of Life: A Model for the Effect of Heterogeneous Importance Weights." Sociological Methods & Research 35 (4): 455–496.

Holz-Rau, C., Scheiner, J., & Sicks, K. (2014). Travel distances in daily travel and long-distance travel: what role is played by urban form? Environment and Planning A, 46(2), 488–507.

Kain, J. 1968. Housing Segregation, Negro Employment, and Metropolitan Decentralization. The Quarterly Journal of Economics. 82: 175–97.

Kelly-Schwartz, A. C. (2004). Is Sprawl Unhealthy? A Multilevel Analysis of the Relationship of Metropolitan Sprawl to the Health of Individuals. Journal of Planning Education and Research, 24(2), 184–196.

Koohsari, M. J., Badland, H., & Giles-Corti, B. (2013). (Re)Designing the built environment to support physical activity: Bringing public health back into urban design and planning. Cities, 35, 294–298. Land Use Consultants (2004). Making the links: greenspace and quality of life. Scottish Natural Heritage Commissioned Report No. 060 (ROAME No. F03AB01).

Li, H., Campbell, H., & Fernandez, S. (2013). Residential Segregation, Spatial Mismatch and Economic Growth across US Metropolitan Areas. Urban Studies, 50(13), 2642–2660.

Mohit, Mohammad Abdul. 2013. "Quality of Life in Natural and Built Environment –

An Introductory Analysis." Procedia - Social and Behavioral Sciences 101 (November): 33–43. doi: 10.1016/j.sbspro.2013.07.176.

Moudon, Anne Vernez, Chanam Lee, Allen D. Cheadle, Cheza W. Collier, Donna Johnson, Thomas L. Schmid, and Robert D. Weather. 2005. "Cycling and the Built Environment, a US Perspective." Transportation Research Part D: Transport and Environment 10 (3): 245–61. doi: 10.1016/j.trd.2005.04.001.

Murphy E., Killen J.E., 2011. Commuting economy: An alternative approach for assessing regional commuting efficiency Urban Studies, 48 (6), pp. 1255-1272.

Nakanishi, Hitomi, Hamish Sinclair, and Jessica Lintern. 2013. "Measuring Quality of Life: An Integrated Evaluation of Built Environment." In CUPUM 2013 Conference.http://cupum2013.geo.uu.nl/download/usb/contents/pdf/shortpapers/70_Nakanishi.pdf.

Puskorius, S. 2015. "The Methodology of Calculation the Quality of Life Index." International Journal of Information and Education Technology 5 (2): 156–59. doi:10.7763/IJIET. 2015.V5.494.

Song, Yan, and Daniel A. Rodríguez. "The Measurement of the Level of Mixed Land Uses: A Synthetic Approach." Carolina Transportation Program White Paper Series, 2016.

Verdugo, Miguel A., Robert L. Schalock, Kenneth D. Keith, and Roger J. Stancliffe. 2005. "Quality of Life and Its Measurement: Important Principles and Guidelines." Journal of Intellectual Disability Research 49 (10): 707–717.

Van Dyck, D., Cerin, E., Conway, T. L., De Bourdeaudhuij, I., Owen, N., Kerr, J., Sallis, J.F. (2012). Perceived neighborhood environmental attributes associated with adults' transport-related walking and cycling: Findings from the USA, Australia and Belgium. International Journal of Behavioral Nutrition and Physical Activity, 9(1), 1.

Ward Thompson, Catharine, Jenny Roe, and Peter Aspinall. 2013. "Woodland Improvements in Deprived Urban Communities: What Impact Do They Have on People's Activities and Quality of Life?" Landscape and Urban Planning 118 (October): 79–89. doi: 10.1016/j.landurbplan.2013.02.001.

Yang, J., Ferreira, J.R., 2008. Choices versus choice sets: a commuting spectrum method for representing job-housing possibilities. Environ. Plan. B 35 (2), 364–378.